The final most probable value of the parallax was $\pi = 8''.800 \pm 0''.006$, which agrees remarkably well with the value announced by A. R. HINKS[1] from a discussion of some hundreds of plates of *Eros* taken at twelve observatories during the opposition of 1900. He gives $\pi = 8''.807 \pm 0''.0027$. This amounts to knowing the Sun's mean distance within about 30,000 miles.

V.

The observing programme of 365 stars now under way at the Cape Observatory will contain when completed the radial velocities of at least fifty stars, observed near quadrature with the Sun, suitable for the determination of the solar parallax. So that in a few more years the spectroscopic determination of this important astronomical constant—the scale of the solar system—may equal in accuracy the aberration method (rated by Professor YOUNG among the best), to which it is closely related, depending, as it does, on the ratio of the velocity of the Earth to the velocity of light.

COLLEGE OF CITY OF NEW YORK,
August 24, 1912.

ORBITS OF THE VISUAL AND SPECTROGRAPHIC BINARY STAR *EPSILON HYDRÆ* AB.[2]

BY R. G. AITKEN.

It has not been possible up to the present time to verify the orbit elements of a visual binary star by independent computations based upon measures of the radial velocities in the system, and it appears that the number of cases in which such verification will be practicable will always be small. As a rule, the revolution periods of the visual binaries are so great that the orbital velocities of the components, except at periastron, are very small. The low inclination of the orbit planes of some systems, the ill-defined lines in the spectra of others and in

[1] *Monthly Notices*, February, 1912.

[2] Read at the meeting of the Astronomical and Astrophysical Society of America, Allegheny, Pa., August 27-30, 1912.

many others the faintness of both components, still further reduce the number of visual binaries that promise well for spectrographic investigation. Again, when we examine the very short period visual binaries, δ *Equulei*, κ *Pegasi*, etc., we find that the two components are usually of approximately equal brightness, and so close together that their spectra cannot be photographed separately. The two spectra are superposed on the plate, and even in δ *Equulei*, the visual binary of shortest period, the lines are separable only at the time of periastron passage.

Special interest, therefore, attaches to the few systems known at the present time which offer favorable conditions for measures both with the micrometer and with the spectrograph, and particularly to the system of ϵ *Hydræ*, the only one for which we now have the data for a double investigation of the orbit. These data are the micrometer measures from discovery by SCHIAPARELLI in 1888 to the present year, covering an arc of 450° of the apparent orbit, and spectrograms taken at the Lick Observatory during the twelve years from November, 1899, to December, 1911. Fortunately, although the period is about fifteen years, the observed radial velocities include both the maximum and the minimum values, since the components pass through both nodes in about two years' time. All the elements except the period can therefore be determined from them.

The first investigation of the orbit of ϵ *Hydræ*, made by the present writer in 1903, gave a period of 15.7 years. This orbit still satisfies the observed position-angles within 10°, but the residuals for the last few years are all positive. The first step in the present investigation, therefore, was a complete revision of the orbit elements on the basis of the micrometer measures. The resulting period was 15.3 years (= 5,588 days). Adopting it as correct, the elements of the spectrographic binary were then computed, with results for T, e and ω that agreed with the elements of the visual orbit within their range of error. It was then an easy matter to find, by a few trials, a set of elements which would satisfy both the micrometer measures and the observed radial velocities within the error of observation. These elements follow:—

Visual Orbit.		Spectrographic Orbit.	
P	15.3 years	P	5588 days
T	1900.97	T	J. D. 2415375
e	0.65	e	0.65
ω	270°.0	ω	90°.0
i	+49°.95	V	$+36.79^{km}$
☊	104°.4	K	8.45
a	0″.23	$a \sin i$	$493,000,000^{km}$
Angles increasing			

The inclination is regarded as positive because the radial velocity of the bright star at the time of its passage through the nodal point (104°.4) was decreasing algebraically. As the values of ω differ by 180° in the two orbits, the ascending node is really at 284°.4.

From these elements and SEELIGER'S mass ratio, quoted below, we find the mean distance between the two components to be $1,359,000,000^{km}$, the parallax of the system to be 0″.025, and its mass 3.33 times the Sun's mass.

There is a third star (C) in the system which has been measured with respect to AB since its discovery by STRUVE in 1825. In this interval the angle has advanced about 40°, but the measures have shown periodic groupings. Using my preliminary orbit of AB, SEELIGER has shown that these can be completely accounted for by the orbital motion of the binary. The two components of the binary differ fully two magnitudes in brightness. Assuming the effective light center of AB to be one-seventh of the distance from A toward B, SEELIGER determines the mass ratio $m'/m = 0.9$.[1] In terms of the Sun's mass, the two components have masses 1.75 and 1.58 respectively.

Within the next five years the companion will pass through both nodes and also through the periastron point, hence the radial velocity of the primary will reach both maximum and minimum values. Spectrographic observations are greatly to be desired during this interval, particularly as micrometer measures are impossible at time of periastron. By 1917 the data should be available for a definitive discussion of the orbit of this system.

August 10, 1912.

[1] While SEELIGER'S assumption of the position of the effective light center may not be quite exact, it is certainly near the truth, and the masses given are probably approximately correct. Thus, if we assume the light center to be one eighth of the distance from A to B, the mass ratio becomes 0.8, and the mass of the binary 3.78 times the Sun's mass.

NOTE.—In the discussion of this paper at the meeting of the Astronomical Society, Professor HENRY NORRIS RUSSELL added the following interesting data relating to this system:—

"According to the Revised Harvard Photometry the magnitudes of the components of the wide pair (AB and C) are 3.53 and 6.77. If the Sun's absolute magnitude is taken as 4.75, it would appear as a star of magnitude 7.75 at the distance of ϵ *Hydræ*. The combined light of the close pair (AB) is therefore nearly fifty times that of the Sun, while the more distant companion (C) gives about 2.5 times the Sun's light.

"The faint companion (D), still farther away (20″), which shares the proper motion of the system, is estimated at from $12^m.5$ to $13^m.0$. It must actually be only about one one-hundredth as bright as the Sun.

"The principal component of the close pair is much the brighter of the two and must give out more than forty times the Sun's light. Its spectrum is F8, and it is therefore probable that its surface brightness is not much greater than the Sun's. Assuming it to be twice as great (a liberal allowance), the diameter of this star would be about 4½ times that of the Sun and its density only one sixtieth of the Sun's density—much lower than that of the average eclipsing variable of spectral class A or B—which suggests that ϵ *Hydræ* is still in a rather early evolutionary stage.

"The fainter component (B) of the close pair must be a good deal brighter than the Sun, but as we do not know its spectral type it is impossible to estimate its density. It may, however, exceed *Procyon* in brightness, as it does in mass."